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The Portuguese Railway Locomotive Assembly Industry: An adaptability perspective

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Abstract

In this paper the Portuguese locomotive manufacturing industry is addressed, in particular how the firms involved create value and adjust adaptability, through interaction over time. The paper deals with an empirical research carried out to analyze the way firms interact strategically and manage constraints and opportunities within their relationships, from the industrial networks perspective.

Keywords: Adaptability, Interaction, Relationship, Supply Network, Strategy

Objectives

In this paper the Portuguese locomotives railway industry is analyzed, in particular how companies in a dyadic customer-supplier relationship interact strategically and manage the constraints and opportunities affecting the industrial network created. To that purpose, we empirically analyze the process through which customer and supplier manage adaptability in order to create value, and if that value justifies the development of a locomotive assembly collaborative platform (Portuguese and Germany assets) in Portugal (RailOpenShop).

The Railway Assembly Industry

The railway manufacturing industry has undergone, during the last decades, a globalization process of concentration with a clear trend for train standardization on family products. Within this process, most of the local country railway manufacturers were subject to acquisitions and integrated into the worldwide OEM's. Demand for railway locomotives has significantly increased in recent years, particularly from Eastern Europe, due to needs of cargo transport and railway liberalization. Since the early days of railway transport this market has been extremely important for the manufacturing companies and today the three big suppliers working as OEM (Alstom, Bombardier, Siemens) try to secure their local customers with customized business agreements.

The European Market: Historically, the supply of rolling stock was heavily related with infra-structure specific conditions that constrained train dimensions, energy and signaling systems. Rolling stock supply relied on the local operator expertise to develop trains for each line and service type. Local investment policies and government control of railway business made difficult any attempt to create common specifications and a standardized train offer. The rolling stock industry developed slowly and until the 1980's the main strategic changes occurred within a process of industry concentration.

This process generated less than five European players (OEM), specialized on the integration of systems and subsystems to their own rolling stock. Such systems could be supplied by internal or external capabilities. The industry adopted an integration supply chain model (Figure 1) based on the outsourcing. Therefore, most of the local country based manufacturers were integrated in the OEM supply chain and continued to supply the local railway

operations. This has allowed the OEMs to guarantee the local authorities that the concentration would not reduce the local industrial activity.

More recently, the new European Directives for better Railway Service Competition, and their transcription into internal laws allowed some standardization, making possible the supply of railway transport needs in Europe from sites located outside each country. As a result, the OEM integrators concentrated again their operations in European wide production centers closing most of their local industrial operations.

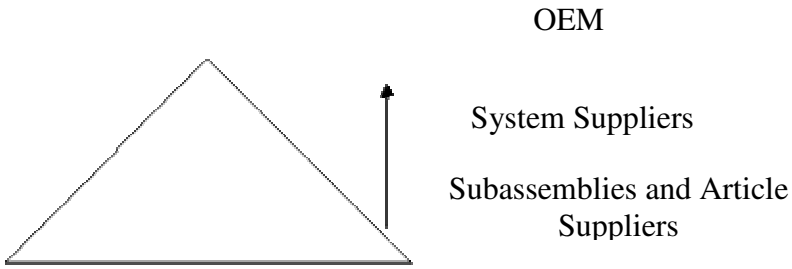

Figure 1 - OEM industry supply chain organization after outsourcing

The Portuguese market: The Portuguese rolling stock industry started in the 1950's based on trade agreements for technology and structural engineering process transfer, made available from the BUDD Company (US) to its Portuguese partner (Sorefame). By the 1970's the production was based on high engineering capacity to supply stainless steel train bodies. Train production under full responsibility of the Portuguese site, started in the 1980's. The production of other components such as bogies, also allowed the company to export to external customers (Figure 2).

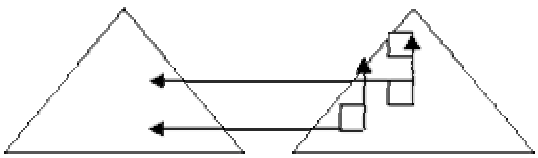

Figure 2 - The 1980's. Component production to internal and external needs

By 1994 Sorefame was bought by the Swedish ABB that later joined Daimler Benz (Adtranz group) in the process of industry consolidation. The network logic for the Portuguese site relied on an ambitious development program based on the vision that all the strategic units would have an opportunity to upgrade their competences and become self-sufficient or, in alternative, face closure. This program included the admission of 30 engineers from different specialties and the transference of outside expertise (specialists from other units) from centers of excellence inside the group. By the end of the 1990's the Portuguese unit was a reference in innovation inside the Adtranz group, with good financial situation and new production structure (robotic assembly and new production process).

In the second half of the 1990's the rolling stock industries changed dramatically. The OEM business position evolved from local product customization to a broad product development approach based on an European specific platform for each service (LRV, Suburban, Regional, Intercity and High Speed). Similarly to the automotive industry, each platform was associated to a brand name and an image and since then production responsibility was no longer shared with the local railway operators. At present, the OEMs tried to go further in this process of concentration, developing shared platforms to different train services. The underlying idea to the creation of these platforms was to gain flexibility and cost/time reduction through the development of configurable train options at the same site.

As a result, excess of production capacity existed at the beginning of 2000. In the Portuguese case, the assembly unit was excellent in assembly process but failed any attempt to improve the local supply network and dropped the development of their components. As a result they became totally dependent of external supply chains.

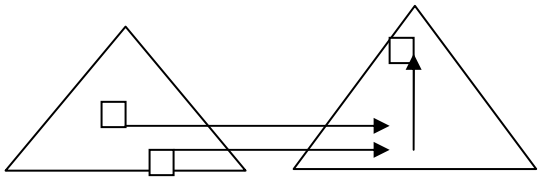

Figure 3 - The 1990's. Industry reliance on external suppliers

In 2001 the Portuguese assembly unit was sold to the Bombardier group and the market conditions changed again, market for trains becoming short for the existing capacity. Rolling stock tenders became extremely competitive. For the first time the Portuguese rolling stock orders for new rolling stock for suburban transportation services were delivered to assembly in Spain. In 2004 the Bombardier Portuguese assembly unit was closed, after a last attempt to achieve an agreement with the Portuguese Government in order to envision a strategic plan for rolling stock investments in future years.

In the 1990's the main Portuguese operator (CP) developed a company (EMEF) whose mission was to maintain and refurbish the rolling stock in the Portuguese market, based on its own long established industrial infra-structure. In an attempt to improve profitability, this company tried to gain new assembly competences based on the refurbishing business. After 2005, the positive development of passenger and cargo railway services and the need of new rolling stock seem to be too demanding for the supply side. This lack of global supply created an opportunity window to establish a relationship through the creation of a collaborative platform between supplier (Siemens) and customer (EMEF). The new competencies and shared resources generated will allow a common answer to diversified tenders (locomotive production/maintenance/repairing and rehabilitation) from south Europe, South America and Maghreb.

Research Questions

In the industrial network approach (Håkansson et al., 2009) a network is defined as "a structure where several clearly identified heterogeneous actors (e.g. a company, a department, a dyadic relationship) are linked by specific interdependences". These actors own specific identities and characteristics according to the resources and activities they develop. (Axelsson and Easton, 1992; Håkansson and Snehota, 1995).

In an industrial network companies have limited opportunities to act independently of their partners decisions (Håkansson et al., 2009), and of the degree of interconnection and dependence in their relationships. The possibility of attaining their objectives also depends on how the other actors plan, act and react to its performance (Wilkinson and Young, 2002). Thus, the achievement of internal resource efficiency and the effectiveness in external negotiations are mutually dependent and potentially conflicting aspects that require interaction (Gadde et al., 2003). The strategy is conceived as a bilateral process, interactive and adaptive, where the action is defined over time by the relationships between actors in the various dyads (Wilkinson and Young, 2002; Canning and Brennan, 2003).

The company action within dyadic or network contexts induces strategic concerns, systematized in three industrial network paradoxes (Ford et al., 2002):

1. How will the actors position themselves in the industrial network and how will they define priorities in internal and external resource allocation to invest in network relationships, knowing that the application of scarce resources in a specific process restrains their use in alternative relations. Those priorities constrain the level of

interaction in the relation (Gadde et al., 2003) and the company needs to equate if it should confront or, inversely, conform to the existing operational conditions.

This paradox relates to the first question addressed. Based on a long dyadic relationship of more than twenty years, we want to identify in the dyad the interaction processes that can be carried out in a collaborative way (Portuguese railway locomotive manufacturing – RailOpenShop) supported on the value generated by those interactions.

2. How to effectively manage the relationships in order to simultaneously coerce, control and influence the network relations, to attain specific objectives without restraining the efficacy and innovation; how to concede to partner's initiatives to avoid negative reactions.

3. How to manage knowledge limitations about the surrounding world. What are the candidate relationships to invest in, in order to maintain or alter the actor industrial network position and how to exert influence or accept influence exerted by other actors (Johanson and Mattsson, 1992).

These paradoxes relate to the second question. We want to understand how the dyadic actors manage adaptability in the relation, and how their strategic action supports their resource economy, in a way it allows them to develop activities and enter new markets. In the Portuguese context the availability of industrial resources and know-how from both partners allowed them to expand activities in Portugal and in external markets.

Conceptual Background and Research Metodology

The industrial network perspective on strategy includes elements of context, process and content (Pettigrew, 1985). The paper develops on the dyadic relationships as the contextual domains where strategic actions and reactions occur (Brennan et al., 2003). The analysis of those strategic actions and reactions, and ensuing results, relies on a number of characteristics/factors developed accordingly to the systemic approaches oriented to adaptability/flexibility in industrial networks (Wilkinson and Young, 2002).

The industrial network approach states several motivations in development of relationships (Zerrillo and Raina, 1996):

- To access resources which are controlled by other actors, directly linked to partners;
- To exert power and control over the partners and their resource collections;
- To obtain common benefits in the relationship ensuring reciprocity between partners;
- To achieve internal efficiency promoting adaptation in relationships, through optimization of exchange processes.
- To obtain flexibility, through simultaneous management of change and stability within the industrial network, as an adaptive response strategy to the alterations of existing market conditions.

The adaptability concept refers to the willingness to reshape supply chains whenever necessary, without ties to legacy issues. An adaptable supply chain is able to adjust its design to meet structural shifts in markets, new supply network strategies, changes in products and technologies (Lee, 2004). Strategy, as envisioned in the adaptability concept, can be described as a process to achieve a flexible and agile industrial network associated with the way how resources are interrelated. A further characteristic of an adaptable supply chain is the

alignment between the elements and activities to changes and opportunities in the network (Christopher, 1998; Sharifi and Ismail, 2005).

The recent and dramatic change of Portuguese railway manufacturing industry resulted in the disappearance (2005) of its main factory, having an impact on the dyad to such an extent that the customer decided to fill the gap by itself with the help of the supplier. The idea of a train operator business unit (EMEF) to become a local industrial manufacturer evolving within a dyadic relationship in a very short time frame represents a new perspective in the railway business.

The railway industry product and process characteristics are far different from the automotive cases where flexibility is centred on 'lean' supply chains (Becker, 2007). The railway industry concept of an adaptable and flexible dyad seems to rely more on the flexible outcomes such as knowledge management and development (Wadhwa, S., Saxena, A., 2007) and autonomous cooperation (Hülsmann *et al.*., 2008) than on the design, process or product features like standardization and modularity (Mason and Lalwani, 2008).

Dyad relationships approach – the case study

The analysis is exploratory and qualitative (Silverman, 2004) based on a case study (Yin, 1994; Stake, 1995) of a dyadic relationship (Figure 4) between the main Portuguese industry locomotives customer and one of its main suppliers.

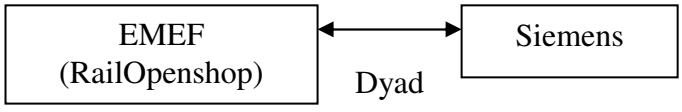

Figure 4 – Focal dyad

It is our purpose to empirically describe the key events in the relationships established over time, using multiple primary and secondary sources, in order to increase knowledge on the problem under study (Easton, 1998). The unit of analysis is established in the mediated relationship, obtained by the perception that managers of the companies involved have on the operational systems and organizational resources used (Axelsson and Easton, 1992).

According to Håkansson et al., (2009), the analysis of the dyad interaction requires the distinction between the temporal contexts (typification of relationship) that have occurred over time in the relationship. For each time interval the context is addressed through a particular episode of interaction. These episodes are driven by past interactions and expectations of future interaction (Håkansson et al.., 2009). The sequence of contexts is guaranteed by the connection between past and future episodes.

The interaction model (Halinen et al.. 1999; Håkansson, et al.. 2009) proposed by the relational approach supports the concepts of individuality for each episode in what concerns network logic, actors specificity and their subjective views, as well as in the ability to interpret a situation (time and situation dependence).

Jahre et al.. (2006) use this model of interaction across different moments proposing the concept of temporal continuity of the relationship (Figure 6).

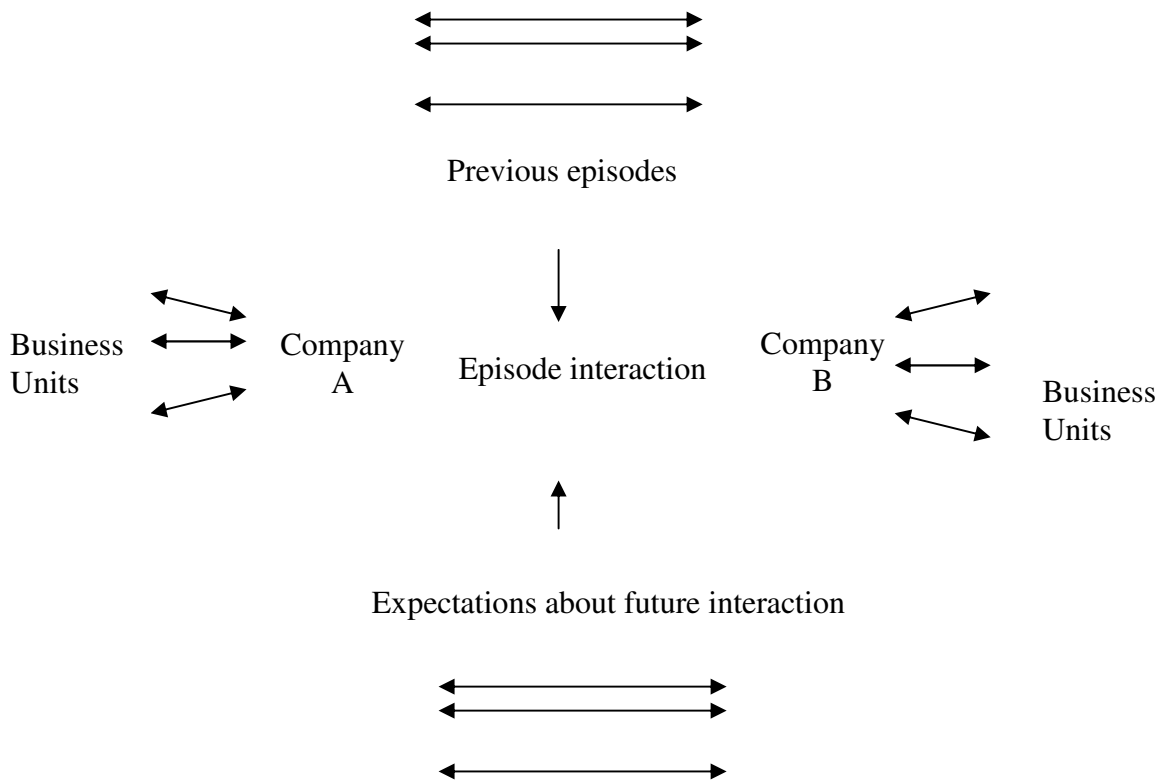

Figure 5 –The interaction model adapted from Jahre et al. (2006)

The paper appeals to this model, considering each episode as a supply order/contract for rolling stock. A contract for supply railway rolling stock is a very complex event, limited in time with typical duration of 3-4 years, generating a number of interdependencies throughout the product life cycle. The data was collected on the three contracts (Table 1) involving the customer and the supplier from the 1990's to the present.

Empirical data on the contextual nature of the relationship needed to understand the process of interaction in the dyad were obtained by semi-structured interviews carried out during the second semester of 2009. The respondents were managers of these companies. Given the need to achieve focus and a high degree of involvement between researchers and the interviewed, an interview guide was developed. (Maaloe, 2007).

Table 1 – Events			
Relationship	**Episode 1 - (E1)**	**Episode 2 – (E2)**	**Episode 3 – (E3)**
EMEF-Siemens	CP5600 - Electric Locomotive (LE) Siemens-Kauss Maffei, built in Germany and Portugal in 1991/3.	UME3400 - Bombardier Electric Multiple Unit, built in Portugal in 2001/2	CP4700 - Electric Locomotive (LE) Siemens, built in Germany and Portugal in 2006/9

Semi-structured interviews

The interviews guide was designed after listening to the industry experts and analyzing reports and other available technical documents. The industry participation and the selection of events were achieved through a workshop (January 2008). A total of 18 interviews were conducted to study the dyadic relationship EMEF / Siemens. An ad hoc approach was used (Kvale, 1996, 2006) to analyze the results of the interviews, by applying elements of condensation, categorization, narrative and interpretation to the experts testimony.

The guide for each episode included a number of questions related to a particular theme to be addressed in the interviews. These themes reflect five dimensions representing different visions of interaction structure defined in the literature, namely, the value (Gadde and Håkansson, 2001; Johnson and Selnes, 2004), the integration/adaptation (Brennan, 2002), the adaptability/flexibility (Ford et al.., 2002; Sharifi and Ismail, 2005), the resource (Håkansson

et al.., 2003) and the relational dimensions (Turnbull et al.., 1996, Ford et al.., 2002). However, this paper only details the aspects of the adaptability strategy analyzed.

The results of the interviews were recorded as written text (Kvale, 1996, 2006). Indicative tables were prepared from the textual records (with a scale of 1 to 6; 6 as maximum value) of how the degree of importance attributed by respondents to the questions formulated was perceived by the interviewers Consolidated tables were later prepared taking into account the various responses. After that these tables were presented to the respondents for validation.

Table 2 - Issues addressed in the interviews

A - Criteria for establishing the relationship

• Nature of the product and the production process (Pagh and Cooper, 2000; Hill, 2000)

• Factors influencing adoption of the product by the customer (Kotler et al.., 2001)

• Factors affecting the level of interaction, the ability for negotiation and action in the relationship (Bäckstrand, 2007).

B - Alternative suppliers

- Existence of alternative suppliers (Anand and Khanna, 2000, Lambe et al.., 2002)
- Existing supplier partnerships (Morgan & Hunt, 1994; Varadarajan & Cunningham, 1995; Borys & Jemison, 1989)

C - Objectives, problems and value associated to the events

- Based on documentary industry review and considering experts rail workshop
- Income, volume and business assurance (Walter et al., 2001)

D - Actions during the events • Action (Håkansson et al.., 2009)
E - Relationship boundaries • Level of interaction between individuals (Håkansson and Snehota, 1995)
F - Solutions to increase customer participation in the supply • Positioning and efforts to influence partners (Johanson an Mattsson, 1992; Henders, 1992; Axelsson and Easton, 1992; Ford et al.., 1998, 2002)
G - Resources allocated to ensure increased local participation • Resources allocated by partners in the dyad (Penrose, 1959; Barney, 2001; Håkanson and Snehota, 1995)
H – Modular supply • Unilateral strategies *vs*. bilateral process • Company diferent supply chains (Cooper et al., 1997) • Dyad boundaries (Gadde et al.. 2003)
I - Degrees of freedom affecting the adaptability of the relationship • Constraints of adaptability inherent to the product and to the environmental factors (Christopher, 1998; Sharifi and Ismail, 2005) • Economic criteria (Porter, 1985)
J –Structure of the relationship • Transformation/change options (Axelsson and Easton, 1992)

Findings and discussion

A – Criteria for establishing the relationship

Characteristics of the production process –The availability and the direct control of manufacturing resources are considered as being of primary importance to the dyad, allowing the customer to better influence the supplier in making the production line available for the new order within a relatively short time frame. The proximity between production location and place of usage is considered as an important flexibility factor allowing a more frequent contact between customer and supplier. These contacts are important for the customer to follow production on requirement fulfilment, quality concerns, test and certification procedures and for the supplier to reduce transportation costs. The testing and certification procedures to check for the absence of negative impact from the vehicles in the railway line (infra-structure) are mandatory and have to be locally performed. The failure to meet the test and certification requirements means that the vehicles have to be technically adjusted in the customer infra-structure with significant cost (rework, parking, protection) for the supplier.
Process standardization, production scale, coordination between production activities, speed coordination with external suppliers, and process specificity, are less important features.

Characteristics of product adoption that influence decision – conformance with specific customer requirements, anticipated test in supplier premises before contract and benchmarking on product usage in various operating contexts are considered as being of high importance. The customer and the supplier obtain flexibility trough the anticipated knowledge of the main product behaviour in specific operative conditions, allowing them to adjust the technical requirements on the contract. The locomotive project slightly changes from one contract to another to adjust to new customer requirements and operative conditions.

Factors influencing the interaction – Trust, duration and closeness of relationship are considered important and help the communication, the sense of security and the experience and knowledge transfer, fundamental to build and maintain the locomotive. The influence of political and institutional facilitators (context) is an important flexibility factor. The influence of actor power is of growing importance and helps the process of influencing political and institutional context conditions.

Table 3 – Topics addressed in A	**Importance Level (1 to 6)**		
	E1	**E2**	**E3**
Characteristics of the production Process			
- Process standardization	2	2	2
- Production scale	1	1	1
- Proximity between production and place of usage	6	6	4
- Coordination between production activities	1	1	2
- Coordination speed with external suppliers	1	1	1
- Specificity of process	1	1	1
- Availability of manufacturing resources	5	5	3
- Direct control of manufacturing resources	5	5	3
Characteristics of product adoption that influence decision			
- Conformance with specific customer requirements	3 5	3 5	3 5

- Anticipated test in supplier premises before contract - Benchmarking on product usage in various operating contexts	6	5	6
Factors influencing the interaction			
- Trust	6	6	6
- Influence of power	3	3	6
- Influence of political and institutional facilitators (context)	6	6	6
- Relationship age	6	6	6
- Relationship closeness	6	6	6

B – Alternative suppliers

It is not predictable that the relationship might be in risk due to supplier and customer commitment to long term relationships. Such relationships come into practice by the signature of protocols aiming the common assembly, maintenance and knowledge transfer (centre of competence development) for the railway business.

C - Objectives, problems and value in the events

Objectives – market share and relational strengthening are considered as important. Market share is a flexibility factor since it economically justifies the development of local engineering staff on the supply side. This is of utmost importance in supporting the customer

during the knowledge transfer process. Those competences are used to create new products in various areas (testing, supervision, maintenance) to sell to the market.

Problems – time between decisions, knowledge availability in the relationship and knowledge transfer capacity (proficiency) needed to increase the customer engineering and workmanship competence, all affect the strategic action and flexibility in the dyad.

Value – financial return in the relationship, long term supplier stability and after sales service are considered important. The undervaluation of the financial return in a specific contract allows flexibility in the relation. The capital flows to the supplier have a minor initial value becoming more constant over time. The benefit transfer due to a contract occurs during all the locomotive life cycle.

Table 4 – Topics addressed in C	**Importance Level (1 to 6)**		
	E1	**E2**	**E3**
Objectives			
- Market share	6	6	6
- Relational strengthening	6	6	6
- Knowledge transfer	4	4	4
Problems			
- Time between decisions	6	6	6
- Knowledge availability in the relationship	5	4	4
- Knowledge transfer capacity (proficiency)	3	4	4
- Customer engineering and workmanship competence	3	4	4
Value			

- Financial profitability in the contract	3	3	3
- Financial profitability in the relationship	6	6	6
- Long term supplier stability	6	6	6
- After sales service	6	6	6

D – Actions during the events

During the first and second contracts the action has mainly focused on the product characteristics, not on the production process. On the third contract the dyad action expands to the production process and to the industrial competence management. The need to respond to market conditions creates a growing interdependence in the dyadic relationship.

E – Relationship boundaries

In the first and second contracts (events) the collaboration between the customer and the supplier takes place mainly through product oriented interaction of its technical teams. This cooperation between staffs facilitates further increase of the interactions. In the third contract collaboration includes the development of market orientated partnerships.

F - Solutions to increase customer participation in the supply

In the first and second contracts the definition of the relationship strategy and objectives is beyond the scope of the dyad (customer - is based on a government perspective) limiting the customer - supplier flexibility and capacity to develop more joint activities. In the third

contract, the responsibility of setting strategy and objectives of relationship is within the scope of the dyad (customer - is based on a market perspective) increasing the flexibility in the interaction and allowing the redefinition of the customer position in the access to the vehicle assembly activity.

G – Resources allocated to ensure/increase local participation

Financial resources – Project predictability influences the capacity to establish a sequence of projects and capital needs. This is important because all train components (high unitary value) must be specified by the supplier and ordered to other suppliers for batch production.

Engineering resources – Product certification and homologation are considered as very important and a mandatory obligation. Requirement specification is a technical document about performance conditions, its detail preventing further operational problems. Performance deviations usually cannot be fixed after production. This document is the main reference to contract development.

Human Resources – qualified workmanship availability and product engineering competence are considered of extreme importance, allowing using the same industrial resources in more complex activities.

Stakeholders - product certifying companies and state and regulatory actors are considered of major importance.

Production activities – product specification, assembly, product test and trial, product certification and homologation are considered as being of major importance. They are needed to allow a permanent use of industrial resources and to serve new orders. Component assembly requires the creation of resources, specific to a single product, not flexible as the other production tools, and are not considered as an investment priority in the dyad.

Table 5 – Topics addressed in G	Importance Level (1 to 6)		
	E1	**E2**	**E3**
Financial Resources			
- Financial autonomy	3	4	5
- Contract value	4	6	3
- Project predictability	6	6	6
Engineering resources			
- Requirement specification	6	6	6
- Product standardization	2	2	2
- Production technology	6	6	6
- Product certification and homologation	6	6	6
Human Resources			
- Qualified workmanship availability	6	6	6
- Product engineering competence	6	6	6
Stakeholders			
- Subassembly suppliers	6	6	3
- Product certifying companies	2	4	6
- Financing	6	6	6
- I&D	2	2	2
- State and regulatory	6	6	6
Production activities			
- Product specification	6	6	6
- Component assembly	3	3	1

- Component procurement	2	2	1
- Assembly	6	6	6
- Product test and trial	6	6	6
- Product certification and homologation	6	6	6
- Commercial activity	2	2	2

H – Modular supply

In the first two deliveries the logic of industrial concentration generated weakened dyad manager's expectations, so the EMEF had great difficulty in raising industrial capacity. The third contract allowed strategic redefinitions on projects and investments. The joint investment focuses on knowledge transfer to improve the technology infrastructure and methods that each actor embodies in their activities. Flexibility is achieved by focusing assembly activity in only one of the actors (customer) and supplying it by modular systems.

I – Degrees of freedom affecting the adaptability of the relationship

Product Characteristics – These characteristics are very stable and are scrutinized by the customer over time. The life cycle cost, delivery, performance and after sales service are of major importance and impact on the stability of the relationship over time. In the product operation a number of safeguard measures are considered as for example idle times to protect the customer from deviations in performance or availability. If the locomotive performs well in the short term those idle times can be removed with greater profitability for the customers, if it doesn't perform according to contractual conditions profitability will be destroyed.

Delivery, quality and pre-sales service are considered of less importance. Deviation in the delivery times is not significant when compared with certification deviation times. Quality is assumed as guaranteed and depends on external suppliers. Pre-sales service is mainly institutional.

Flexibility, conceived as the possibility to change the product during production, is avoided due to the extreme cost (project change, new component batch). The project and main concept is offered the customer and all the technical adjustments are decided before establishing the contract and starting production. After production, the technical changes are minor and only related with software changes to alter the train behaviour.

Innovation is secondary in the Portuguese industrial context since the main concern is risk avoidance. Innovative product features are only accepted after they are tested by train operators in main European countries like Germany or France. Product specific innovations are also considered difficult to maintain due to high cost.

Table 5 - Topics addressed in I	**Importance Level (1 to 6)**		
Product Characteristics	**E1**	**E2**	**E3**
Life cycle cost	6	6	6
Delivery	3	3	3
Quality	4	4	4
Performance	6	6	6
Flexibility	1	1	1
Innovation	1	1	1
Pre sales service	3	3	3
After sales service	6	6	6

Environmental Factor Evaluation – Industry regulation (European Directives) is of growing importance over time. The legislation was conceived to allow the market liberalization. As a result, the customer lost some traditional activities (e.g. local regulation) or the exclusivity for a number of others (e.g. train certification/homologation). The customer needs help from the supplier to regain the competence needed to do the certification/homologation activities, and both use the dyadic relationship to adapt to the new legislation and gain new markets. Compatibility between new and already existing products (locomotives) is not important since they don't interact operationally/technically. Inversely, compatibility between the product and the infra-structure (train and railway line) is critical, since they customer and the supplier cannot finish the contract without external product certification/ homologation.

Table 6 - Topics addressed in I **Environmental Factor Evaluation**	**Importance Level (1 to 6)**		
	E1	**E2**	**E3**
Activities			
- Industry regulation	1	4	6
- Compatibility between new and already existing products (locomotives)	1	1	1
- Compatibility between the product and the infra-structure (train and railway line)	3	2	1

Economies – economies of integration/focus, as well as economies of scale (number of locomotives for each contract) are considered also relatively important. Innovation is only

related with complementary products (test tools, supervision hardware and software). Interdependence economies are considered important and develop within the dyad dynamics.

Table 7 - Topics addressed in I **Economies**	**Importance Level (1 to 6)**		
	E1	**E2**	**E3**
Economies of integration/focus	1	1	1
Economies of scale (number of locomotives for each contract)	1	1	1
Innovation Economies	1	1	2
Interdependence Economies	4	4	4

J - Structure of the relationship

This is a highly technological complex system that only makes sense within the dyad. The change pace of the relationship is considered to be high throughout the three period contracts, forcing the actors to reposition over time. Actor positioning in the dyad has become more flexible covering a wider range of activities (engineering design, maintenance, component repair, vehicles rehabilitation, development of test equipment for components, certification/approval of vehicles) allowing the gradual implementation of new activities based on the acquisition of skills. This flexibility is supported by long term formal partnership agreements (e.g. technical competence centre). The organizational culture alignment is considered important to the success of the relationship.

Table 8 - Topics addressed in J **Relational structure**	**(1 to 6)**		
	E1	**E2**	**E3**
Structure (simple/complex)	6	6	6
Change pace (low/high)	6	6	6
Actor positioning (rigid/flexible)	1	1	4
Formalization Characteristics (contracts e procedures)	2	2	4
Informal Characteristics (value, commitment)	5	5	6

Conclusions

These results provide a starting point for discussions concerning the mechanisms that can be used to promote flexibility in relationships on the locomotive assembly industry. The purpose is to identify resources and capabilities that allow the successful implementation of local supply collaboration platforms. This paper addresses a customer-supplier partnership in an industrial network perspective to understand how adaptability value was developed between them allowing a new proposal for emerging markets.

The two key processes in building an adaptive collaborative relationship are:

- Locomotives assembly at the customer site - allows these activities to be locally performed, supported by supplier-customer staff and technology and placed close to the infrastructure that will be used by the equipment.
- Certification and approval of vehicles – allows the inclusion of these activities in the dyad in order to explore new business opportunities.

Consequently, to ensure value in the relationship, the customer and the supplier hold their collection of resources in order to be compatible with their overall strategy inside and outside

the dyad. The customer must organize the industrial assets and the supplier the knowledge/capabilities assets, without resorting to business integration. This splitting mechanism allows tensions avoidance and awareness of new opportunities under the dyad. The success of the partnership depends on the balance between the flow of skills from supplier to customer and the performance of operations on the supplier.

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